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Analysis of nutrition mixtures in ITU patients

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Abstract

Background. The aim of this study was to analyse the composition of parenteral nutrition (PN) mixtures used in the ITU.
Methods. Restrospective analysis involved 2124 prescriptions for individual PN bags. They were administered over an 18-month period, to 160 ITU patients with the mean APACHE II score of 26 points (range: 5-61), calculated on admission. The mortality rate was 40%. Nutrition programs were prepared individually following the 2009 ESPEN guidelines. The prescription was modified according to the individual patient's clinical condition. One hundred and sixty prescriptions were analysed on the first day of PN (T_1), 139 – on the second day (T_2) and 1825 on the third and subsequent days (T_3).
Results. The mean energy supplies were: 1381 kcal/day (range: 456-2612) on T_1, 1467 kcal/day (range: 524-2860) on T_2, and 1654 kcal/day (range: 390-2969) on T_3. The mean supplies of amino acids, glucose and lipids were as follows: amino acids 68.3 g/day (range:20-120) on T_1; 71.6 g/day (range:27.5-125) on T_2; 88.0 g/day (range:11-196) on T_3; glucose 210.25 g/day (range: 120-400) on T_1; 218.34 g/day (range: 65-480) on T_2; 278.5 g/day (range: 18-520) on T_3; lipids 34.9 g/day (range: 0-100) on T_1; 38.7 g/day (range: 0-100) on T_2; 52.66 g/day (range: 0-117) on T_3. The percentages of non-protein energy from lipids were: 29.25 (0-73) on T_1; 31.58 (range: 0-60) on T_2; 33.5 (0-60) on T_3. The following statistically significant differences were found: T_2-T_3- ($p<0.05$).
Conclusions. The compositions of nutrition bags prepared for ITU patients were consistent with the ESPEN guidelines. The composition varied on different days of nutrition. The differences in the supply of nutrition components indirectly confirm the need for individual prescriptions for ITU patients.

Key words: nutrition, parenteral

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Every several years, experts of the two world leading societies dealing with nutrition of patients, i.e. the European Society for Clinical Nutrition and Metabolism (ESPEN) and the American Society for Parenteral and Enteral Nutrition (ASPEN), update the guidelines on nutrition in various clinical situations, including ITU cases. The newest guidelines were published in 2009 [1, 2]. According to ESPEN, parental nutrition should be initiated on day 3 of ITU hospitalisation, unless enteral feeding can be instituted within the nearest 24-48 h. On the other hand, ASPEN recommends administration of parenteral nutrition on day 7 if there were no earlier clinical and laboratory features of malnutrition and enteral feeding is not possible [1, 2].

To initiate parenteral nutrition, certain conditions should be met, i.e. the patient's general condition has to be stabilized (recovery from shock, correction of circulating blood volume), tissue perfusion improved, arterial and venous pressure stabilised. Moreover, carbohydrate, electrolyte and acid-base metabolism should be normalized. One of the contraindications for parenteral nutrition is acidosis (pH

7.2; serum lactate >4 mmol L^{-1}) [1, 3, 4]. Patients ought to be breathing spontaneously or be effectively supported by lung ventilation, have normal diuresis or renal replacement therapy adjusted to the therapeutic needs.

According to both Societies, parenteral feeding should be introduced gradually and slowly, starting with minimal recommended amounts of nutrients and increasing them simultaneously, monitoring the suitable parameters. According to ASPEN, full demands should be covered on day 7-10 of nutrition. The European guidelines assume that the initial energy supply should be 25 kcal kg_{ibw}^{-1} day^{-1} (ibw – ideal body weight), which has to be gradually increased in the subsequent 2-3 days. According to ASPEN, the energy supply should range between 22-25 kcal kg_{ibw}^{-1} day^{-1}. The ESPEN guidelines state the range of amino acid supply of 1.3-1.5 g kg_{ibw}^{-1} day^{-1} whereas ASPEN recommends >2 g kg_{ibw}^{-1} day^{-1}, or even 2.5 g kg_{ibw}^{-1} day^{-1} in some cases. ESPEN assumes that patients should receive 2 g kg_{ibw}^{-1} day^{-1} of glucose and 0.7-1.5 g kg_{ibw}^{-1} day^{-1} of lipids. Both Societies agree that all vitamins and microelements should be administered from the onset of nutrition and electrolytes supplied suitably to needs. Moreover, lipid emulsions containing medium-chain fatty acids MCT/LCT are beneficial. Additionally, administration of nutrients affecting positively the immune system, i.e. ω-3 acids and glutamine, is recommended [1, 2].

According to both Societies, basic vital functions should be continuously monitored and the nutrition modified suitably to the patient's clinical condition [1, 2]. The latter is pivotal to successful nutrition therapy.

The aim of the study was to analyse the composition of mixtures for parenteral nutrition administered to ITU patients.

METHODS

The study design was approved by the bioethics committee. The retrospective analysis involved prescriptions for individual nutrition mixtures used in ITU patients between July 2009 and February 2011. In each case, the parental nutrition (PN) programme was based on the ESPEN guidelines of 2009; the mixtures were modified suitably to the patient's clinical condition and results of additional tests. Moreover, balance of fluids, serum concentrations of glucose, urea, triglycerides, and electrolytes as well as arterial blood acid-base balance results were considered. Additionally, test results of hepatic and pancreatic functions were analysed. The analysis concerned the first day of PN (T_1), the second day (T_2), the third and further days (T_3).

The results were statistically analysed using the Student's t-test. P<0.05 was considered statistically significant.

RESULTS

The analysis involved 2124 prescriptions of individual PNs administered to 160 patients; 160, 139 and 1825 prescriptions were analysed at measurements points T_1, T_2 and T_3 respectively.

The mean APACHE II score was 26 (range 5-61). Sixty percent of patients underwent surgeries before ITU admissions; 36% of admitted patients were diagnosed with two-organ failure, 34% with three-organ failure and 29% with failure of four and more organs. In most cases, circulatory, respiratory insufficiency and septic shock were observed. In total, 40% of patients died.

The total energy supply at individual measurement points is presented in Fig.1. There were no significant differences in energy supply between points T_1 and T_2; however, the difference between T_1 and T_3 was found significant (p<0.0001).

The supply of all nutrients and volumes of PN bags at individual measurement points are presented in Table 1. There were no differences in the analysed parameters between T_1 and T_2. The supply of all parenteral nutrients (except for magnesium) was significantly higher at T_3 than at T_1.

DISCUSSION

ITU patients often suffer from multiple organ failure, which requires an interdisciplinary and multidirectional approach. One of the elements of such an approach is parenteral nutrition therapy. The nutrition planning should involve not only energy requirements but also possible use of individual components of nutrition mixtures.

Planning of PN therapy in critically ill patients should consider stress malnutrition characterized by metabolic phenomena different from those in cases of simple starvation. Due to severe trauma or sepsis, deficiencies of some substrates impair numerous processes in the body, especially in malnourished patients [5, 6].

Metabolic disorders in ITU patients are multifactorial. Hypermetabolism cannot be limited unless the underlying disease is controlled. The suitable nutrition therapy reduces the complications associated with malnutrition during stress. Thanks to proper assessment of nutritional requirements, complications caused by an excess or improper proportion of substrates can be avoided. Once the nutrition therapy is decided (particularly in ITU patients), special attention should be paid to increased risk of complications, especially the overload or re-feeding syndrome. The latter is caused by the shift of fluids between the extra- and intracellular space, impaired phosphate, potassium, magnesium and glucose metabolism and vitamin deficiency [1, 5, 7].

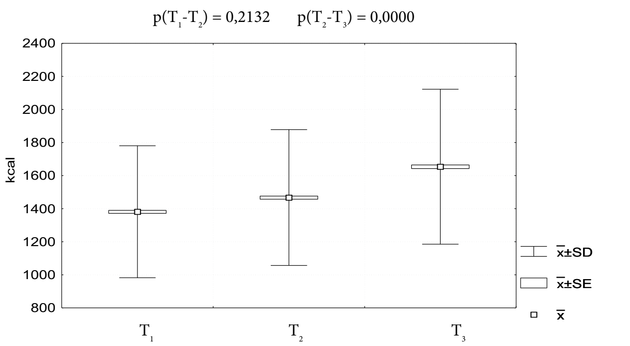

Fig. 1. Total energy supply at measurement points T_1, T_2 and T_3

Table 1. Composition of nutrition mixtures administered during 24 h – median (range)

	Measurement points				
Component	T_1	T_2	T_3	(T_1 vs T_2)	(T_2 vs T_3)
Coefficient α (kcal g N-1)	103.4 (44-234)	102.2 (30.8-312)	102.3 (11-303)	p	p
Amino acids (g)	66 (20-120)	70 (27.5-125)	80 (11-196)	NS	<0.0001
Glutamine (%)	0 (0-42)	0 (0-29)	13 (0-40)		
Lipids (g)	40 (0-100)	41 (0-100)	41 (0-117)	NS	<0.0001
Glucose (g)	200 (120-400)	200 (65-480)	225 (18-520)	NS	<0.0001
Kcal total	1341.5 (456-2612)	1416 (524-2860)	1584 (390-2969)	NS	<0.0001
Lipid kcal (%)	32 (0-73)	32 (0-60)	35 (0-60)		
Non-lipid kcal	1104 (380-2168)	1150 (296-2386)	1298 (190-2575)	NS	0.0002
Na (mmol)	58.5 (0-162)	60 (0-162)	54 (0-216)	NS	0.0128
K (mmol)	50 (0-140)	60 (0-160)	40 (0-180)	NS	0.0016
Mg (mmol)	4.8 (0-28.5)	4.8 (0-28)	6.4 (0-32)	NS	NS
Ca (mmol)	7.87 (0-18.9)	8.55 (0-27)	9 (0-36)	NS	0.0004
P (mmol)	13.15 (0-34.6)	13.15 (0.15-62.5)	14.9 (0-75)	NS	0.007
Volume (mL)	1425 (763-2460)	1500 (680-2540)	1622 (540-2950)	NS	<0.0001

The PN mixtures analysed were prescribed according to the ESPEN guidelines and modified suitably to the patient's clinical condition and method of treatment. In our material, the mean energy supply ranged from 1381 kcal day^{-1} to 1653 kcal day^{-1}, whereas the range of supply was much wider. As recommended, the nutrition was instituted gradually, hence the differences in supply of individual components between the second and subsequent hospitalization days. The differences in electrolyte supply confirmed the need for everyday control of their serum concentrations and modifications, if required. This management was proper as potential complications were avoided.

Although the necessity of indirect calorimetry in ITU patients is still disputed, many authors stress the benefits resulting from this method of nutrition monitoring. The energy supply is often markedly lower than expected from real demands and the mortality rates are higher when energy expenditure is not determined by calorimetry (47.7% *vs* 32.3%) [8]. The study involving 2772 patients treated in 167 ITUs demonstrated substantially lower percentage of deaths among patients with BMI <25 kg m^{-2} and >35 kg m^{-2} receiving higher energy mixtures [9].

Moreover, there are opinions that the supply of energy and nutrients should be higher than recommended by ESPEN or ASPEN. Some authors state that in ITU patients the mean daily energy demand determined by indirect calorimetry is 34±3 kcal kg^{-1}, whereas the protein demand – 2.125±1 g kg^{-1} (lack of data whether of ideal or real body weight) [10]. Others believe that daily energy expenditure in critically ill patients ranges from 1330 to 1980 kcal [11]. According to some other researchers, energy supply should not exceed 36 kcal kg^{-1} day^{-1} [12].

The daily supply of 2153 kcal and its gradual increase over 6 days up to 2431 kcal plus protein supply in a dose of 2.5 g kg^{-1} day^{-1} (at constant total energy supply) was demonstrated to be more beneficial than administration of proteins in the doses of 1.5 and 2 g kg^{-1} day^{-1} [13].

In our study, the mean daily supply of proteins ranged from 63 to 82 g, and of glucose from 210.25 to 239 g; however, the supply range was much wider. The mean non-protein energy supply calculated per one gram of nitrogen (coefficient α) was 108-106, and the percentage of lipids in non-protein calories was 29.25-33.5. The ranges of nutrients administered were markedly wider and exceeded the values recommended by ASPEN, i.e. 70-100.

CONCLUSION

The compositions of nutrition bags recommended for parenteral nutrition in intensive therapy units were consistent with the ESPEN guidelines yet varied with the consecutive nutrition day.

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